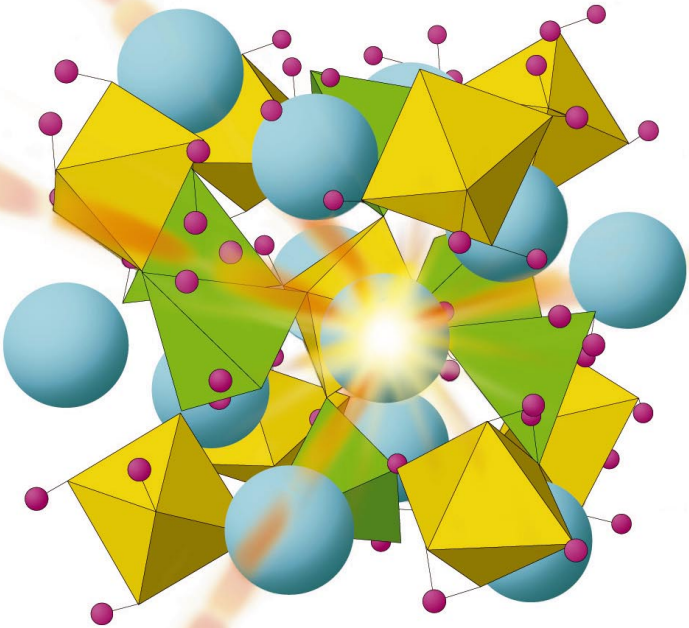
Spallation Neutron Source

The next-generation neutron-scattering facility for the United States



Advancing the Frontiers of Science and Technology

A U.S. Department of Energy multilaboratory project

SNS
SPALLATION NEUTRON SOURCE

Audiotapes and videotapes. Compact discs and computer disks. Credit cards, cosmetics, and clothes that don't wrinkle. Safer aircraft and automated car seats and windows. Low-fat, tasty ice cream and life-saving bulletproof vests. Peanut bags that don't easily rip apart and plastic toys that kids can't break.

These are some of the "new things" of the second half of the 20th century that have improved our quality of life. These materials have been improved by using beams of the building blocks of the cores of atoms—neutrons. If you bounce a beam of neutrons off atoms in a crystal and measure the directions and energies at which the neutrons "scatter," you can determine how the atoms in the crystal are arranged and how they interact. The properties of any material are largely determined by how its atoms are arranged and how they interact with each other. Such "neutron scattering" experiments have produced information that has guided the design of better materials and the manufacture of better products that we use every day.

The U.S. Department of Energy (DOE) is building the world's best accelerator-based, pulsed-neutron system, called the Spallation Neutron Source (SNS), in Oak Ridge, Tennessee. Six DOE national laboratories are involved in designing this powerful scientific tool. Like a flashing strobe light providing high-speed illumination of an object, the SNS will fire pulses every few instants at a target. Those pulses will contain 6 to 10 times more neutrons than are produced at the most powerful pulsed neutron sources in the world. Just as we prefer a bright light to a dim one to read the fine print in a book, researchers will prefer this source of "brighter" neutrons. It will give more detailed snapshots of the structure of even the smallest samples of physical and biological materials, from plastics to proteins. And it will make "movies" of molecules in motion.

The SNS is being designed and built as a partnership among six DOE national laboratories: Lawrence Berkeley in California, Los Alamos in New Mexico, Argonne in Illinois, Oak Ridge in Tennessee, Brookhaven in New York, and Jefferson in Virginia.

So, what new things might we expect from neutron science in the next millenium if the United States has a new SNS by 2006? Here's the stuff of dreams that might be realized faster with the help of neutron scattering at a new SNS:

- Drug-delivery systems that release a medicine precisely when and where it is needed in the body to relieve pain without side effects
- Artificial blood, which will reduce the need to screen blood for life-threatening viruses and find the right blood type in an emergency
- Medical implants like artificial hips and knees that last a lifetime, eliminating the need for more operations to replace worn-out parts
- Lubricants specially tailored for tomorrow's more efficient, emission-free car engines
- Superconducting wires and stronger magnets that will bring lower power costs and much faster trains that will "float" above magnetic tracks
- Stronger, lighter materials for improved products (e.g., safer, faster, more energy-efficient aircraft)

"A brighter source of neutrons could bring a brighter future"

Magnetism & Superconductivity

High-speed trains of the future that will be levitated by superconducting magnets will be even faster than the TGV in France (shown here).

Polymers

Much of the Boeing 757 airplane is made of lightweight plastic. Neutron studies may lead to safer, faster, more energy-efficient aircraft.

Disordered Materials

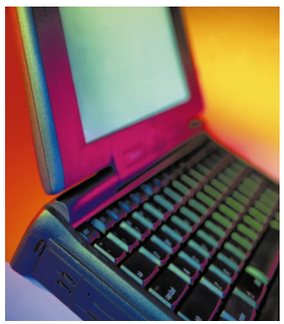
Intense neutron beams will offer clues on preparing better surfaces of wear- and corrosion-resistant alloys for use as hip implants.

Complex Fluids

Shampoo is one of many complex fluids studied with neutrons whose molecular structure changes as a one-directional force is applied, making the thick liquid thin enough to spread through hair.

Crystalline Materials

Thin films that can be probed by the SNS will be used for nonvolatile memory, extending the life of laptop computer batteries.



Semiconductors

Smaller, faster electronic chips that may result from neutron studies will bring low-cost power devices and the convenience of smart cards and ubiquitous computing.

Structural Biology

Using neutron scattering to determine the structure of body enzymes will aid in the development of more effective therapeutic drugs.

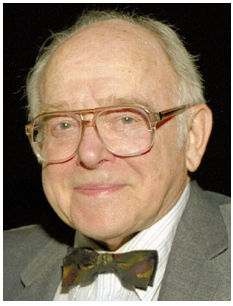
Chemistry

Healthier, low-fat foods (like ice cream) that have better taste and texture will be made with guidance from neutron scattering.

Engineering

The Corbin Bridge in Pennsylvania was the first to have an aluminum deck replacement (in 1996). Aluminum welds for such decks are being characterized by neutron scattering.

Because they have no charge, neutrons penetrate more deeply into materials than do X rays, light, or electrons and thus reveal bulk structure and properties of materials. The results of experiments at a brighter neutron source will complement those from the other probes, plugging gaps in our knowledge about materials.



Nobel Laureate Clifford Shull was among the Oak Ridge National Laboratory researchers who pioneered neutron scattering by using neutrons from the Laboratory's Graphite Reactor.

What is spallation? When a high-energy proton bombards a heavy atomic nucleus, some neutrons are "spalled," or knocked out, in a nuclear reaction process called spallation. Other neutrons are "boiled off" as the bombarded nucleus heats up. For every proton striking the nucleus, 20 to 30 neutrons are expelled.

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